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Fixation and Regression in the Rat

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TABLE OF CONTENTS

PART I

	Page
INTRODUCTION	1
STATEMENT OF THE PROBLEM	3
METHODS	5
Apparatus	5
Subjects	6
Procedure	7
Natural preference	7
Habit A	7
Habit B	7
Critical trials	7
Test for strength of fixations	7
RESULTS	8
Response to shock	8
Measures of the strength of habits formed by shock	10
The effects of blocking a response to shock	10
The effects of a change in the positive alley	10
The effect of the omission of shock upon the mode of response adopted in the shock situation	10
The effect of shock in the terminal alley upon the fixated response	11
The effect of forcing variability of response upon the fixating animal	12
SUMMARY OF PART I	13

PART II

INTRODUCTION	14
STATEMENT OF THE PROBLEM	14
METHODS	15
Apparatus	15
Procedure	15
Subjects	16
RESULTS	16
Comparison of P, R, and D groups	20
Comparison between experimental and control groups	24
SUMMARY OF PART II	28
DISCUSSION AND CONCLUSIONS	28
GENERAL SUMMARY	33
BIBLIOGRAPHY	34

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FIXATION AND REGRESSION IN THE RAT[1]

PART I

INTRODUCTION

A NUMBER of studies have been carried out in recent years purporting to have demonstrated in rats a phenomenon analogous to the phenomenon of regression in human beings (3, 7, 15, 16, 19). Most of these studies employed situations and techniques designed to fit the requirements of the Freudian definition of regression. In very general terms, this definition may be stated briefly as the adoption by the organism of a mode of response typical of an earlier developmental stage, when the organism is faced with a situation to which it cannot adapt in terms of more mature levels of behavior. In translating this definition into experimental conditions that can be adapted to animal investigations, certain liberties are taken with it. The experimenter controls the "development" of the rat by training the animal to react in a particular way in a controlled situation. "Development" is achieved by making the first habit an inadequate or uneconomical way of reaching the goal, and by providing another way by which the rat may attain the goal with less effort. Thus in this situation the first habit is considered to be analogous to the "immature developmental" level and the second habit to the "mature" response. That the analogy is crude cannot be denied. Shock is then introduced into the situation presumably to create an emotional disturbance (3, 7, 19) or to frustrate the animal in the performance of his "mature" response (15).

[1] A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the University of Michigan.

The particular pattern for these studies stems from the work of Hamilton and Krechevsky (7). In this one and in succeeding studies (3, 14, 16, 17, 18, 19, 20) some form of the two-choice apparatus was used. All were either one unit T-mazes or modifications thereof. Each was also provided with an electric grid so that shock could be applied at the choice point. Martin (14) and Mowrer (15) are exceptions to this. Martin employed a more complex situation for a part of his work, i.e., a Krechevsky type discrimination box which consisted of a series of four two-choice discrimination boxes. The shock could be applied at the start of each run in the starting box. Mowrer's apparatus differs most from the others and consisted of a problem-box in which the animal could escape shock by depressing a lever.

In the typical experiment the animal is first trained to one alley of the T-maze and then to the other. After training on the second position habit is completed, the animal is shocked at the choice point on one or more trials. If on the shock trial he selects the alley to which his earlier training was directed, he is said to have regressed. Mowrer's procedure differs from this only in that the animal first learns to remain motionless on the grid in order to reduce the subjective intensity of the shock. In his second habit he learns to depress the lever to turn off the shock. Then in the critical situation the animal is shocked when he touches the lever. If he adjusts to this situation by assuming a motionless pose on the grid (the first habit), he is said to have regressed.

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The results and conclusions from these studies are listed here for convenience of presentation.

1. With shock an animal selects a response and ceases to deviate from that response. Everall (3). Hamilton and Krechevsky (7). Sanders (19).

2. With shock the animal may discontinue the habit in progress and select an earlier learned response even if this earlier response is no longer an objectively adequate response in terms of the goal, i.e., the animal may regress. Everall (3). Hamilton and Krechevsky (7). Martin (14). Mowrer (15). O'Kelly (16). Sanders (19).

3. The response selected with shock is genetically characteristic of the animal. Sanders (19).

4. The response selected with shock may be influenced by frequency of repetition in learning. Everall (3). Martin (14).

5. In a complex situation, in which the shock is administered before the animal is permitted to run in the situation, the animal tends to persist in the second habit. Martin (14).

6. The reversion to the earlier habit is produced by the strong emotional disturbance which accompanies shock. Everall (3). Hamilton and Krechevsky (7). Sanders (19).

7. The shock produces the reversion to an earlier habit not because of the emotional disturbance produced, but because it serves as a specific frustration to the habit in progress. Mowrer (15).

8. Clear-cut differences exist between the animals that persist in the habit in progress and those that select the earlier habit with shock. O'Kelly (16).

9. Motivation shifts from food-getting to escape from shock with the occurrence of electric shock. O'Kelly (16).

10. The animal's reaction to shock depends upon the conditions under which the animal gained its past experience. O'Kelly (17).

11. The animal's response with shock will be in the direction of the response which has previously been followed by a reduction in tensions. O'Kelly (17).

The conclusions listed above may be accepted with varying degrees of confidence. Some are facts, others opinions tentatively promulgated by the investigators in hopes that they may be substantiated by further research. There is, it will be admitted, a certain amount of selection involved in the compilation of this list, so that others with different theoretical interests could wish for a more expanded enumeration, or one with different emphasis. However, the present discussion and experimental proceedings shall be shaped in reference to these conclusions.

Since the work on regression has been either an outgrowth of studies of habit fixations or has been associated with such investigations, it will be well to examine this concept also. There has been, particularly in regression studies, some confusion as to the use of the term fixation. The most frequent confusion arises from the tendency to consider lack of variability and fixation as one and the same.

Maier (11) draws what is, in the author's opinion, a clear and necessary distinction between these two mechanisms. It may often be that lack of variability is indicative of fixation, but it most certainly is no proof of fixation. Thus if an organism responds in an unchanging, repetitive way to the demands of a situation, we may say that it lacks variability, but we may say that it is fixated only if the organism continues to react in this unvarying way after the demands of the situation have been so altered that another response is required. The term

fixation for the above mentioned phenomenon seems to be in most general usage, although others have been suggested, e.g., perseveration (3), and behavior constancy (5). Fixation, however, is not to be confused with persistence (6).

STATEMENT OF THE PROBLEM

If one considers the behavior possibilities of the animal when he is shocked in the two-choice regression situation outlined above, one is struck by the fact that these possibilities are so limited by the nature of the apparatus and the training procedures used that any interpretation of them must necessarily be ambiguous. These possibilities may be listed as follows:

I. The rat may continue in the habit in progress. This habit shall be called Habit B.

II. The rat may actually go back to the first habit. This habit shall be called Habit A.

III. The rat may discontinue going to Habit B which in the two-choice situation would be evidenced behaviorally by:

A. Going to the alley trained to in Habit A, or

B. Refusal to run.

IV. The rat's behavior may be disrupted, which would be evidenced by a random selection of either alley.

The first possibility (I) we shall call perseveration after O'Kelly. This shall mean only that after shock the animal continued in Habit B. In previous studies this type of behavior was found in widely varying amounts, but the average would be about 50% of the cases.

Because only one shock trial was given in some of the studies, the fourth possibility, disruption, was not always investigated. In order to determine if a disruption of behavior occurs it seems certainly necessary to run the animals with shock at the choice point for a number of trials.[2] However, in the studies permitting the testing of such an hypothesis (3, 7, 15, 19), the results are negative. With shock the great majority of animals seem to select a response and adhere to it without alteration.

Refusal to run (III, B) occurs in a relatively large proportion of the studies. Why it was not a problem in all the studies seems strange, unless there were wide variations in the strength of the shock employed. It is believed, however, that the probable significance of this for the problem at hand is no greater than that which would be raised by an ordinary motivation study on the obstruction box. The parallel between the obstruction box and the apparatus used in these studies is obvious. Of more interest

[2] The author feels that this point is sufficiently interesting to warrant further discussion. Probably the reason that only one shock trial is run in these studies (16, 17, 18) is because the animal soon refuses to cross the grid. Another objection that may be raised to running the animal more than once to shock is that learning or some mode of adaptation to shock occurs. Those animals that refuse to cross the grid can be easily made to do so by designing the apparatus so that they may be shocked for such refusal. The rat's resistance is overcome by a very few such shocks, the average being not quite two. By getting a number of shock trials, not only is the data on the first run available in case it should somehow prove unique, but also the additional data on subsequent runs is obtained. A more important argument that renders the above argument somewhat superfluous is that continued shock is more analogous to the human situation. Human regression is not brought about by a single traumatic incident, even though it may be precipitated by such an event. Rather it is an adaptation to a continuing frustrating situation. This, it is believed, would still hold even though the continuation were brief and restricted to a particular situation, as in temporary and situational regression of Barker, Dembo, and Lewin (1). One shock trial is too brief a cross section of the process of adaptation to shock to claim with confidence that an analogue of regression has been demonstrated. Then, too, if an animal regresses on the first trial and perseverates on the next, by what particular virtue is the first trial endowed that we may classify this animal as regressive?

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possibly are the animals who continue running across the grid with increasing persistence and without benefit of any additional motivation.

Of greatest interest is the distinction between II and III, A. In other words, do the rats actually return to Habit A or do they merely discontinue going to Habit B. In the typical regression experiment it may be either, because the apparatus and the training procedure prohibit such a distinction to be made. Maier, Glaser, and Klee have recognized that this distinction cannot be made in the two-choice apparatus as long as the animals have been given training in both alleys. They ask, "If another group had formed the left position habit only and if it was then shocked, would this group also respond by going to the right in the same proportion . . ." (13, p. 542) as a group which had first been given a right position habit and then a left? Recently O'Kelly (17) performed such an experiment with a limited number of rats, and used the first shock trial as a measure of the animal's selection in the critical situation. In his study all animals continued to the alley to which they had been trained rather than to the other, whereas in a previous study (16) in which the animals were trained on two position habits, the animals split their choices almost equally between the right and the left alleys. Thus if they are given only one habit, they continue it with shock. This would seem to allay the objection raised by Maier, Glaser, and Klee in that it seems not to be mere coincidence that the rats select on shock an alley to which they had been previously trained. Mowrer's (15) control group also might serve to answer this objection. In his study the animals that had been given only Habit B (pressing lever to relieve shock) continued in that habit when the lever was charged, whereas the experimental group having had both Habit A and B relinquished Habit B with shock. However, the criticism that regression may be the result of an artifact seems challenging enough to be worthy of a more direct approach. Before considering the problem closed on the basis of O'Kelly's evidence, it would seem advisable to run more shock trials.[2] Again it will be noticed that both Mowrer's and O'Kelly's situation limit the animal's behavioral possibilities by allowing only two alternatives. It would be very enlightening to see if the same conclusions could be drawn about this phenomenon if the behavior possibilities of the rat were enriched while the situation remained relatively simple. This could be done by adding more choices or alleys to the situation. Thus instead of using a two-choice apparatus, a multiple-choice apparatus could be used, e.g., a quadruple-choice apparatus. With such an apparatus the animals could still follow the customary training procedure, i.e., they could be trained in two habits, but with shock instead of being able only either to regress or to perseverate, there is the possibility that a new alley might be selected. We shall refer to this latter possibility as digression.

On the basis of Everall's conclusions (3) we should expect to find no digression unless the alley to which the animal digressed were a naturally preferred one. Sanders (19) would emphasize the genetic priority (natural preference) of the response made to shock. While Martin (14) would agree essentially with Sanders, he would add that training could overbalance the effect of the natural preference. Nowhere is there mentioned the possibility that a new response might be possibly engendered by the shock. It is reasonable that if a new response were

selected with shock in preference to either Habit A or B, the distinction between perseveration and regression would be weakened.

In addition to the control study of regression, it was our purpose to study the fixating effect of shock in this situation. Both Hamilton and Krechevsky (7) and Everall (3) have claimed that shock has a fixating effect, yet in the author's opinion what they really demonstrated in their experiments was that shock reduces the variability of the rat. Hamilton and Krechevsky (7) claim that the fixation produced by shock is of the same order as the fixation produced by overlearning. While this claim may be true, we feel that the comparison is not completely legitimate. Since we have already gone into this distinction between variability and fixation (*vide supra,* p. 2) we shall not go into it further here. Suffice it to say that Krechevsky and Honzig demonstrated fixation because they showed that with overlearning the rat resisted a change in behavior when the situation was altered in such a way as to call forth a change, while Hamilton and Krechevsky merely demonstrated lack of variability in that they measured the fidelity with which the rat selected a response on repeated shock trials. In the latter case, the situation was not altered to see if the animal would resist the change necessary to meet the demands of the new situation. This would have been necessary if fixation were to be demonstrated. The same criticism may be made of Everall (3). She demonstrated that it is more difficult to effect a change in preference while the animal is being shocked at the choice point than when the animal is not given such a shock (3, p. 347). This may mean only that the animal when shocked under such conditions exhibits a change in amount of variability. It does not necessarily mean that fixation has occurred.

It was our purpose to test the fixating effect of shock by determining whether the rat persisted in a response set up in the shock situation, when shock was no longer given and the demands of the new situation were such that the mode of response adopted to shock was made inadequate.

METHODS AND RESULTS

Apparatus

The apparatus designed for this study is presented in Figure 1. The structure was completely enclosed. The top was covered with transparent celluloid, as were the two sides of the central portion from which the terminal alleys diverged, i.e., the sides which were at right angles to the choice point *X*. This was done so that the experimenter standing at *S* could very easily observe the behavior of the rats in the central enclosure. Alleys *I, II, III,* and *IV* were alike in all respects except for their positions and the shape of the alley entrances. The shapes of these openings are indicated by the letters *A, B, C,* and *D* and their positions in the apparatus are indicated by the same device. The forms were cut from pieces of masonite and inserted in position at the entrance of the alley. When the alley was to be blocked, the forms were drawn out and replaced by solid pieces of masonite, thus preventing the animal from gaining access to any part of the alley.

Two swinging doors D_1 and D_2 were placed in each of the terminal alleys. Both of these doors were operated by a gravity system controlled by the experimenter from the starting box. These were cushioned in rubber to reduce the noise of operation. During the experiment proper the doors (D_2) leading di-

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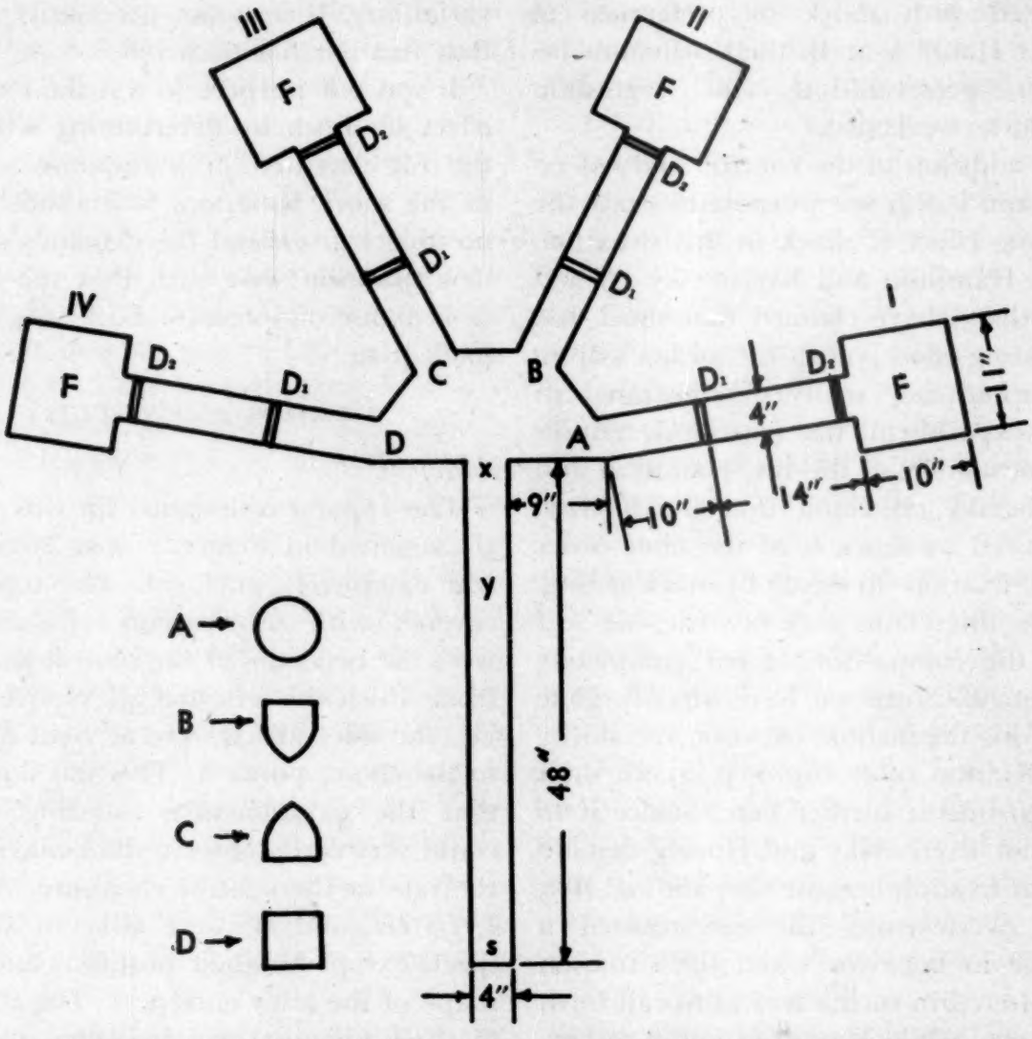

FIG. 1. Apparatus. Detention chamber between D_1 and D_2. For further description see text.

rectly to the food box were closed, the others (D_1) were left open. Thus when the animal reached D_2, the open door, D_1, could be closed behind him. In this way the rat could be detained in this section of the maze for any desired period of time. A grid composed of 3/8" brass rods covered the entire floor of the apparatus up to D_1 in the terminal alleys. The brass rods were placed 3/8" apart and the spaces in between were filled with paraffin. This gave the floor a fairly uniform smoothness and lessened the seriousness of any short circuit that might occur from hairs, urine, etc. The shock was applied by means of an ordinary laboratory inductorium which stepped up the voltage from a single dry cell. The inductorium was kept in an adjoining room in a sound proof cabinet. The door was closed between the two rooms when the shock was being used. In this way the sound produced by the operation of the inductorium was inaudible to the experimenter and to others on the laboratory staff who were consulted on the matter. The shock was applied by means of a small hand switch that could be easily carried by the experimenter.

Subjects

Twenty young, adult, naïve rats, both pigmented and albino, were used. Of

these 10 were males and 10 were females. All animals were well tamed, and had not been used for previous experimental purposes.

Procedure

The animals were first given preliminary training to adapt them to handling and to the experimental procedures by running them 10 trials a day for 5 days in an enclosed straightway. They were run to food after about 24 hours of food deprivation. At the completion of the daily runs they were fed the rest of their rations in their cages. They were fed the regular laboratory mash both in the apparatus and in their cages. This was supplemented at intervals with lettuce and similar greens.

Natural preference. After preliminary training the animals were started on the experimental apparatus and were given 10 trials a day for 8 days in order to determine their natural preferences for the alleys. During these preference runs and throughout the entire experiment the animal received food after every run no matter what alley was selected. The first preference run on each day was considered to be a free choice; however, on the second run the rat found the alley chosen on his first run blocked and was forced to choose another. On the third run he was not permitted to enter the alleys chosen on the first and second trials and on the fourth run only one alley was available to him. Thus the second, third and fourth runs on any of the "preference" days were considered to be forced runs. On the first and second days this forcing procedure was repeated twice during the ten daily runs, so that on these days only the first, fifth, ninth, and tenth trials were free choices, while the second, third, fourth, sixth, seventh, and eighth were forced runs. On the remaining six days only the second, third, and fourth were forced runs, and the first and last six trials were free choices. Thus in 8 days the animals each had a total of 50 free runs and 30 forced runs.

Habit A. The animals were given 50 training trials to alley *II* at the rate of 10 trials a day. The rats received food in any alley they selected. However, in alleys *I, III,* and *IV* they were detained for a period of 90 seconds in the detention chamber (see Figure 1) before being allowed to reach food, but in alley *II,* the positive alley, they were allowed immediate access to the food box.

Habit B. Immediately following their training on Habit A the rats were given 50 trials (10 trials a day) with alley *IV* positive. During these trials, of course, the animals would be detained the usual 90 seconds in alleys, *I, II,* and *III.*

Critical trials. On the day following the completion of the training on Habit B shock was introduced. All features in the situation remained as they had been during the training on Habit B with the exception that the rat was given an electric shock when he reached *Y* (Figure 1), and the shock was continued until he reached *X.* Immediate access to food was still gained through alley *IV,* and the delay periods were maintained.

Up to this point all animals were run every day, but with shock the great increase in the number of errors so extended the time of running (it will be remembered that for every error the animal was detained 90 seconds) that it was necessary to divide the group into 2 groups of 10 each and to run them on alternate days.

Test for strength of fixations. After the critical shock trials, the animals were subjected to a number of test situations designed to break the response which the animals had set up with shock. Since a

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variety of responses were set up under these conditions, the procedures used to deal with them were also varied. For clarity, therefore, these methods will be presented along with the results.

RESULTS

Response to Shock

A description of the animal's behavior in the shock situation is necessary if one is to understand at all clearly the significance of these results. On the first trial when shock was applied, the animal would give a mild jump at *XY* into the central portion of the apparatus. Then he would almost invariably turn around and begin a cautious investigation of that portion of the grid on which he had received the shock. After finishing this he would proceed upon his way. The next trial would see a more cautious approach to *XY* and also a more violent reaction to shock, if the animal decided to cross this spot. There seemed to be a decided sensitization to the shock. After this second shock not infrequently the animal refused to run. If after five minutes he did not cross *XY*, he was taken from the starting box. Some of the animals exhibited this resistance in the starting box on three consecutive days. In all, 13 animals refused to run after being shocked on the first day.[3] On the average these rats made 3.15 (range = 1-7) runs before this refusal to leave the starting box occurred. In order to force the animals into an active adaptation to the shock situation, it was decided to shock them at *S* through to *X* on as many trials as it would be necessary to get them to run continually. It required an average of 1.54 (range = 1-2) of these shocks to force the animals to run. In this way all 20 rats were run through at least 30 shock trials (average = 35.5, range = 30-46). No distinction could be made between the behavior of the animals which had been forced to run and those which had never had the motivating shock at *S*. All animals settled down to a rapid stereotyped response.

The alleys that the rats selected are shown in Table 1. There are in all four different possible responses in this situation. These responses may be classified according to the alley selected as follows: responses made to the perseveration alley or the alley to which the animal was trained in Habit B (*perseveration*); responses made to the regression alley or the alley to which the animal was trained in Habit A (*regression* in the historical sense); and the responses made to the digression alleys or to either of the two alleys to which the animal had never been trained (*digression*).

As can be seen in Table 1, when all trials are considered, 9 rats continued to run to alley *IV* (perseveration alley), and only 2 chose alley *II* (regression alley), while 9 went to neither of these alleys but rather made a new response to alley *III* (a digression alley).

When it is recognized that the rats run very fast on all but the first few shock trials, it will be readily conceded that the middle alleys (*II* and *III*) are more available than the end alleys (*I* and *IV*). That this factor of accessibility

[3] That this occurs is not surprising. It is more startling that 7 of the rats did not refuse to run on the first day and 5 of these did not refuse on any subsequent day. O'Kelly (16) found such refusals in all of his rats. This difference may be due to the difference in the shock strength. It may also be due to the fact that his grid formed a unique part of the floor of the apparatus, whereas in the present apparatus the grid completely covered the floor up to and into the terminal alleys. In O'Kelly's apparatus shock could be associated with a particular section of the floor, while in our apparatus the shock association in some rats may be generalized to every bit of the floor up to D_1. If this generalization occurs, then *S* (Figure 1) becomes as capable of arousing anticipatory shock reactions as *XY*, and the animal continues to run even though it is shocked each time *XY* is crossed.

undoubtedly influenced greatly the 11 rats that selected middle alleys is indicated by a comparison of the results on alleys *I* and *III*. Since the animals were trained to neither of these alleys we should expect the responses to be divided fairly equally between them. However, all animals that selected a new alley on the critical trials went to alley *III*. Thus we have ample evidence to support the contention that availability of the alley is an exceedingly important factor in determining the rat's selection in the shock situation. That these 9 digressing rats were not going back to a natural preference is indicated by the fact that only 2 of these animals chose alley *III* more than any other alley on their 50 preference runs.

If shock caused a complete disruption of the animal's behavior, we should expect the selections on the critical trials to be equally distributed between the four alleys. Table 1 indicates that this did not occur. The fact that 45% of the animals continued the habit in progress offers decisive evidence that Habit B was not universally disrupted. Since evidence for historical regression would require that of the remaining animals more than one-third should return to the earlier mode of response (alley *II*) rather than selecting either of the two new response possibilities (alleys *I* and *III*), the data in this experiment fail to support this notion of regression. It seems rather that shock either fails to disrupt the habit in progress or it succeeds in doing so. When the habit in progress is disrupted another response is adopted, and if this response corresponds with a natural preference or an earlier habit it seems to be, as far as we may interpret the results of the present experiment, purely coincidental.

Undoubtedly there are additional factors which determine the character of the response which appears if the habit in progress is disrupted. We have already mentioned the availability of the alleys as a possible influence. It is conceivable that factors of this sort cover the influence of previous learning and natural preference. This possibility will be tested in the following experiment (Part II).

TABLE 1

Distribution of rats by alley selected on critical shock trials on the basis of the first shock trial, the last 10 trials, and all shock trials.

	Perseveration Alley	Regression Alley	Digression Alleys	
	IV	II	I	III
First Trial	13	0	1	6
Last 10 Trials	8	2	0	10
All Trials	9	2	0	9

These results agree with other writers in that shock disrupts the habit in progress in about half of the animals, but we have not been able to show with our added controls that disruption is akin to a return to a former habit (historical regression). That this disruption is not immediate in all cases is indicated by the fact that on the first shock trial no disruption of Habit B was shown by 13 animals, while on the last 10 trials only 8 of the rats still continued to go to the alley trained to on Habit B. Thus in some cases there seems to be an accumulative effect of the shock.

An effect of frustration emphasized by Maier, Glaser, and Klee (13) is that of abnormal fixation. It is of interest to determine whether the consistent type of response exhibited in the foregoing experiment is due to this sort of fixation. It is possible that even when shock failed to disrupt the habit in progress a fixation

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may have been produced, thus making this habit even less subject to disruption.

Measures of the Strength of Habits Formed by Shock

In order to determine if the responses to shock were fixated, and if so, to determine the strength of these fixations, a number of further tests were made.

The effects of blocking a response to shock. It was suspected that the reason that so many of the animals digressed to alley *III* was because in attempting to get to alley *IV* they were thrown towards *III*, and soon accepted this as a preferable and more available way of escaping the shock situation. If this hypothesis is true, then if *III* were blocked, the animals should go to alley *IV*. For the 9 digressing animals alley *III* was blocked at the entrance. Aside from this, the conditions remained the same as for the ordinary shock trials, i.e., shock at *XY* and alley *IV* positive. Ten trials were given each rat.

Of the 9 rats 7 ran to alley *IV* on all trials. The shift was immediate, and no confusion was shown. One rat went to alley *II* for 10 consecutive trials, while another went to alley *II* on 3 trials and alley *IV* on 7 trials.

These results suggest strongly that the selection of alley *III* was due to the operation of two determining factors; training on Habit B and the availability of alley III.

In order to determine if these animals would persist in their "new" formed responses if the block were removed, they were run 10 additional trials under the same shock conditions, but with all alleys again open. All rats, with one exception, continued to go to alley *IV*. The exceptional rat went back to alley *III* with the removal of the block. It is interesting to note that this is the animal that split his choice between alleys *IV* and *II* when alley *III* was blocked. No animal went to more than one alley.

The effects of a change in the positive alley under conditions of shock. It would seem a plausible explanation that the animals now perseverating in alley *IV* (this would include the 9 perseverating rats and the 7 rats that shifted their preference to alley *IV* when *III* was blocked) persisted in their response because alley IV was the positive alley, i.e., the one through which the immediate access to food was obtained. If this hypothesis is to be accepted, then a change in the positive alley should disrupt the position habit formed to alley *IV*.

For 14 of the animals responding to shock by going to alley *IV*, alley *II* was made positive. Ten trials were given each rat. All other conditions were the same as an ordinary shock trials.

Of the 14 rats 12 continued to go to alley *IV* on all test runs. One rat was run a total of 30 trials under these conditions and made 11 runs to alley *III* and 19 runs to alley *IV*. Another, a rat which had originally digressed in the shock situation went to alley *III* on all test trials, thus never experiencing the increased detention in alley *IV*.[4] No rat went to alley *II*, the positive alley.

Thus we may conclude that delay in the food alley is not sufficient motivation to cause a shift in preference while shock is being applied at the choice point.

The effect of the omission of shock upon the mode of response adopted in the shock situation. As yet we have presented no conclusive evidence that the rat became fixated with shock. There does, however, seem to be a reduction in variability. This reduction in itself can-

[4] On the day following these 10 runs to alley *III* this animal went back to alley *IV* for all 10 trials.

not be considered sufficient evidence for fixation, because it is conceivable that the animals could still vary their behavior if it were necessary for them to do so, but the responses that they have assumed are so urgently demanded by the shock situation that they prefer not to alter them so as to satisfy normal demands for variation. In this case the response would be considered as an adaptive response to the shock situation. If the rat were responding adaptively in this situation, then with the cessation of shock he would shift his responses to satisfy the demands of the new situation. If he fails to shift his response, we have no reason for assuming that the shock response was adaptive, and certainly the response to the shock-free situation would be an unadaptive one. If this should be the case we may then speak of this response as abnormally fixated and of the shock as the fixating agent.

The 16 animals habitually going to alley *IV* were run in the apparatus a minimum of 20 trials with no shock at any time and with alley *II* positive. Seven of these animals were run 20 trials and 9 were run 30 trials.

The distribution of choices to the various alleys by trials and by number of rats is shown in Table 2. It will be noted that of the 410 choices made by the 16 animals, 2 rats made a total of 3 choices to alley *II*, 6 made a total of 13 choices to alley *III*, and all 16 made a total of 394 choices to alley *IV*. Nine of these rats made 100% of their runs to alley *IV*, and all rats on any single day made a majority of their runs to alley *IV*.

Thus we may conclude that after the removal of shock these animals made no change in preference to meet the demands of the new situation. Before shock had been introduced, these animals shifted their preference from Habit A to Habit B very easily, as is shown by the fact that on Habit A the group of 20 rats made an average of 37.1 correct responses out of 50 to alley *II*, and on Habit B they made an average of 42.55 correct responses out of 50 to alley *IV*. After shock they showed no such tendency to shift from the alley selected under the shock conditions. We are safe then in concluding that shock caused these animals to fixate a particular response. Later (Part II) we shall see this claim further substantiated by the use of a control group retrained in Habit A. The shift from B to A for this group which never received a shock was very easily made.

TABLE 2

Distribution of choices by alleys for 16 animals in the shock-free situation.

Alleys	I	II	III	IV	Total
Number of Choices		3	13	394	410
Number of Rats Choosing an Alley One or More Times		2	6	16	16

The effect of shock in the terminal alley upon the fixated response. As a further test of the strength of the fixated response, it was decided to shock the animals in the terminal alleys for each wrong choice. The same 16 animals fixated on alley *IV* were subjected to these conditions. Alley *II* was still positive and there was no shock at the choice point. The shock for the wrong response was administered as soon as the rat entered the terminal alley and was continued until he left the grid at D1 (Figure 1). All the animals were run at least 20 trials at 10 trials a day. One rat, 182M, was given 30 trials.

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Table 3 makes it clear that even this drastic treatment did not cause the majority of these rats to forsake their fixation on alley *IV*. In fact 11 of the rats made all 20 of their runs to alley *IV* and

TABLE 3

Distribution of choices by alleys for 16 animals run with shock for errors. Based on 20 trials for each animal.

Alleys	I	II	III	IV	Total
Number of Choices		2	20	298	320
Number of Rats Choosing an Alley One or More Times		2	4	16	16

rat 182M made all 30 of his runs to that alley. Only 1 rat showed any decided shift in preference. This animal shifted its preference from alley *IV* to alley *III*, making a total of 15 choices to alley *III* and only 5 to alley *IV*. It was one of the originally perseverating animals. The 2 rats that made 1 choice apiece of alley *II*, the positive alley, did so on the first day of their runs. Thus this one run cannot be considered as indicative of a tendency toward a shift in preference in these two animals.

It is evident from this experiment that shock for error is ineffective in breaking the fixation set up by shock at the choice point. Under the conditions of this experiment the response that all 16 of these animals selected was twice inadequate in the sense that it was an inefficient way of getting at food and that it did not allow them to escape shock.

The effect of forcing variability of response upon the fixating animal. Next an attempt was made to see if forced variation of response would cause the animal to break his fixation. The same 16 animals shocked for selecting wrong alleys in the above experiment were used. Under the present conditions no shock was administered in the apparatus and alley *II* was still positive. The animals were to be run until a disruption of the fixation was evidenced. No rat was run more than 50 trials, including the forced runs. They were run 10 trials a day. After the first run the alley selected on that run was blocked. On the third run the alleys selected on the first and second runs were blocked, and on the fourth run only one alley was open. Thus the second, third, and fourth trials were considered forced runs.

Table 4 shows that on the first day 8 of the 16 rats refused to run after having made an average of 2.13 runs. On the second day 2 more rats refused to run. Thus when the fixation to alley IV was prevented from functioning, 63% of the animals failed to replace their response with another response. This seems to indicate that the animal is fixated upon

TABLE 4

Distribution of rats refusing to run according to the days on which the refusal occurred. The criterion of refusal is 5 minutes in the apparatus without entering a terminal alley.

Day on Which Refusal to Run Occurred	Number of Rats	Average Number of Trials, both Free and Forced Runs, Before Refusal to Run
First	8	2.13
Second	2	13.5

a *particular* response, and that when it is deprived of this response there is nothing to take its place; and so the animal refuses to run. The behavior evidenced in this situation is unlike the behavior of the animals that refused to cross the charged grid. The rats in the present situation would readily go into the central portion of the apparatus, but once there they would go from alley to alley

never more than partially entering any of them.

SUMMARY OF PART I

After the determination of their natural preferences, 20 rats were given two successive position habits in a multiple-choice apparatus. Following this training, they were subjected to a series of critical trials on which shock was administered to them at the choice point. Eleven of the rats showed a disruption in their behavior in that they discontinued going to the habit in progress. Of these 9 reacted to the shock situation with a new mode of response. Since only 2 of them selected an alley to which they had been previously trained, no evidence could be derived from this experiment to support the concept of historical regression as described by other animal experimenters. Nor did this experiment produce evidence to support the hypothesis that natural preference is a determiner of the animal's behavior in the shock situation. The data do, however, indicate that the availability of the alley is a potent factor determining alley selection on the critical trials. It is possible in the present experiment that factors of this sort may have obscured the influence of the training on the earlier position habits and of natural preference.

That these animals had abnormally fixated their shock preference was indicated by the fact that these preferences could not be altered by making them inadequate responses to the shock-free situation. When the fixation was prevented from functioning by forcing the animals to vary their responses, 10 of the 16 rats refused to run indicating that when these animals were deprived of their fixated response they were unable to find an adequate substitute for it.

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PART II

INTRODUCTION

THE experiments described in Part I while admittedly exploratory in nature have, nevertheless, given some results that are quite significant. It is important that these results be verified by further experimentation designed to provide certain necessary additional controls and to provide opportunity for careful observation of the details of the phenomenon of abnormal fixation with special reference to the factors determining the selection of the fixated response.

It has probably already become apparent to the reader that the combination of alleys used in the quadruple-choice situation is probably a very important factor in influencing the number of animals going to the various alleys. It would be expected from the results already obtained that with different combinations of alleys different amounts of the three types of behavior in the shock situation would be found, i.e., responses to the perseveration alley, the regression alley, and the digression alleys. The earlier work pointed to the necessity of training the animals to all possible combinations of alleys. This was an insignificant problem in the customary two-choice situation, but in the quadruple-choice apparatus the only way to obtain reliable figures for the relative amounts of these different types of responses is to train the animals on all possible combinations of two alleys. In this way the systematic errors produced in each combination used will be cancelled out, and by the use of a large number of animals the effects of random errors will be minimized.

If indeed our data reveal that sufficiently large enough groups exhibit the three types of responses in the shock situation, we must recognize the necessity for the compilation of additional distinctions between the behavior of the animals selecting the regression alley, and those who select either a new response or continue in the habit in progress.

While it is felt that the first experiment gave exceedingly convincing proof of abnormal fixation, there was no opportunity for comparison between the shock group and the group subjected to similar conditions but never shocked. Such a group should show strikingly the strength of the fixation formed by shock.

STATEMENT OF THE PROBLEM

In line with the above discussion, the first problem is to determine as accurately as possible with the quadruple-choice apparatus the relative frequency of "shock" responses to the alley trained to in Habit A, to the alley trained to in Habit B, and to alleys to which the animal has received no training.

The second problem is to discover as many differences as possible that may exist between the animals exhibiting perseverative, digressive and regressive responses. This is to be done by a comparison between the groups on such measures as the amount of variability, strength of fixation, reaction to food, etc.

The third aim is to compare the responses of fixating animals with the responses of control animals which have never been subjected to shock.

METHODS AND RESULTS

Apparatus

With the exception of several alterations, the apparatus used in this experiment was the same one used in Part I (Figure 1). Instead of using the inductorium to supply the shock, the apparatus described by Maier (11) was adapted to our needs. For our purpose the resistance was reduced from 30.5 megohms to 15 megohms. A transformer attached to a 60 cycle 220 volt circuit stepped up the voltage to 5,000 volts yielding a maximum current of about .3 milliamperes. The shock was applied by depressing with the foot a double-pole switch in the secondary circuit. This left both hands free at all times and proved to be of very great advantage on the early shock trials when the animals resisted being put into the apparatus.

In the first experiment the entire grid was activated when the current was turned on. To get away from the several disadvantages which resulted from this arrangement, the grid was divided in such a way that various portions of it could be cut out by means of a series of switches. In this way the floor of the initial runway was made a separate grid as were the floors of the terminal alleys from their entrances to D_1 (Figure 1). The central portion could also be controlled as a separate grid.

Procedure

In the present experiment, unlike the first one, there was complete uniformity in the number of trials given each animal and fixation was measured simply by attempting to retrain the animals using exactly the same techniques that were used to train them in their original habits. Only the completely naïve animals were given the preliminary runs in the straightways to accustom them to handling. Animals that had been used on previous learning problems were started immediately on the preference runs. The following schedule of training was used:

1. Preference was determined on the basis of 50 free-choice runs in exactly the same manner described in Part I.

2. The animals were then given 50 training trials on Habit A. Each alley served as a positive alley for this habit for an equal number of rats.

3. The training on Habit A was followed by 50 trials on Habit B. Each of the 4 alleys also served as a positive alley for an equal number of rats on this habit.

4. Each animal was then given 50 critical trials on which he received an electric shock at the choice point (*XY*, Fig. 1) on every run. The positive alley on the critical trials was the same one on which the animal was trained during Habit B.

5. After the critical trials 50 retraining trials were given. The positive alley on these trials was determined as follows: if the animal continued going to Habit B on the critical trials, the alley to which he was trained on Habit A was made positive, but if he discontinued going to Habit B, the positive alley remained unchanged.

A control group was subjected to this same procedure with the following exceptions:

1. Instead of critical trials they were given 50 additional training trials to Habit B (Habit B′).

2. On the retraining trials the positive alley was always the same one to which they had been trained on Habit A.

3. The alley combination used was dependent upon the natural preference of the animal, i.e., they were trained in

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Habit A to their most preferred alley and in Habit B to their least preferred alley.

Twelve sub-groups were formed, each sub-group being trained to a different combination of alleys. The sub-groups with the alleys to which they were trained and the order of training on the alleys are as follows:

Sub-group	*Alley*	
	Habit A	*Habit B*
A_1	II	IV
A_2	IV	II
B_1	IV	I
B_2	I	IV
C_1	III	II
C_2	II	III
D_1	IV	III
D_2	III	IV
E_1	I	II
E_2	II	I
F_1	III	I
F_2	I	III

It will be noted by examination of the combinations of alleys used that each alley was a positive alley on both Habits A and B an equal number of times, e.g., alley *I* was the positive alley on Habit A for sub-groups B_2, E_1, and F_2, and it was the positive alley on Habit B for sub-groups B_1, E_2, and F_1. Thus if each sub-group is to contain an equal number of rats, the influence of training will be distributed equally over all of the alleys. In this way the effect of alley position on the type of response the animal may make in the critical situation will be equalized, since every alley will be a regression alley an equal number of times and every alley will be a perseveration alley an equal number of times. Also, every alley could have as many animals regress to it, as it could have animals to perseverate in it.

Training was carried on over a period of eight months. In any lot of rats in a particular training period an attempt was made to include animals from as many sub-groups as possible. This was to minimize the effect of seasonal and other unavoidable minor changes in conditions.

Subjects

Sixty young adult rats, both white and pigmented, were used in the experimental group. Of these 34 were females and 26 were males. Exactly one-half of the group had had experience on previous learning problems. None had been subjected to shock before. Each of the 12 subgroups contained 5 rats. When training began all animals were well tamed and accustomed to being handled.

The control group was composed of 10 rats, 6 females and 4 males. These rats were of the same strain and age as the experimental group.

RESULTS

The results of the critical shock trials are presented in Tables 5 and 6. On Table 5 we see that 18 or 30% of the animals went to the regression alleys (R), 27 or 45% went to the perseveration alleys (P), and 15 or 25% went to the digression alleys (D). Also we see that on a majority of their shock trials 11 of the animals went to alley *I*, 23 to alley *II*, 24 to alley *III*, and only 2 to alley *IV*. For reasons already discussed (Part I) these results are based upon all 50 shock trials, i.e., we considered that a rat preferred a particular alley if the majority of his shock runs had been to that alley. These results corroborate the findings of the first experiment in that we find three kinds of responses which we shall refer to as P, R, and D. The proportions of these responses differ from the findings in Part I, but since the present data are based upon more animals and the posi-

TABLE 5

The distribution of animals by alley selected on the majority of shock runs. (Based upon 50 shock trials.) N = 60.

Group	Habit A	Habit B	Alley I	Alley II	Alley III	Alley IV	R	P	D
A_1	II	IV		2	3		2		3
A_2	IV	II		3	2			3	2
B_1	IV	I	3	1	1			3	2
B_2	I	IV	4	1			4		1
C_1	III	II		4		1		4	1
C_2	II	III		3	1	1	3	1	1
D_1	IV	III			5			5	
D_2	III	IV			5		5		
E_1	I	II		4	1			4	1
E_2	II	I	4	1			1	4	
F_1	III	I		2	3		3		2
F_2	I	III		2	3			3	2
Total			11	23	24	2	18	27	15
Percentage			18.33	38.33	40	3.33	30	45	25

tions of the alleys are controlled by the use of all combinations, these are, of course, the more reliable figures.

If shock had no effect upon the behavior of the animals we would expect them all to continue in Habit B. Since only 45% did continue we are justified in assuming that shock disrupted the

TABLE 6

The distribution of choices of alleys on shock trials. N = 60.

Group	Habit A	Habit B	Alley I	Alley II	Alley III	Alley IV	R	P	D
A_1	II	IV	2	68	157	23	68	23	159
A_2	IV	II	2	164	83	1	1	164	85
B_1	IV	I	148	51	50	1	1	148	101
B_2	I	IV	162	61	17	10	162	10	78
C_1	III	II	4	201	10	35	10	201	39
C_2	II	III	0	133	69	48	133	69	48
D_1	IV	III	0	2	247	1	1	247	2
D_2	III	IV	0	0	235	15	235	15	0
E_1	I	II	4	211	35	0	4	211	35
E_2	II	I	195	53	2	0	53	195	2
F_1	III	I	13	101	134	2	134	13	103
F_2	I	III	3	64	182	1	3	182	65
Total			533	1109	1221	137	805	1478	717
Percentage			17.77	36.97	40.70	4.57	26.83	49.27	23.90

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habit in progress in a large proportion of the animals. If the remaining rats were merely avoiding the alley to which they had been trained on Habit B, and if this were the only determining factor, their selection of any one of the three remaining possibilities would be completely dependent upon the operation of random factors. In such a case we would expect these animals to be distributed equally over the three remaining possibilities. That is, we would expect one-third of them to exhibit the R response, and two-thirds the D response. The results of the present experiment do not support this hypothesis, because of the 33 rats not continuing in Habit B, 18 showed the R response and 15 the D response. This indicates that training on the first habit may be a determining factor in the selection of a response in the shock situation.

An examination of the responses made by the 15 D animals shows the great influence that availability of the alley had upon their behavior in the critical trials, for of this group 13 responded to the shock situation by selecting a middle alley. The influence of the availability of the alley is likewise strikingly demonstrated by the fact that 78.33% of all the animals went to either alley *II* or *III* with shock. If this factor were not in operation, we should have expected only 50% of the animals to go to these two alleys. So far we have presented evidence showing that if the animal discontinues going to the habit in progress, the selection of the response may be influenced by the training on Habit A and the availability of the alley.

Now we may turn to the effect of natural preference or genetic bias upon the selection of the response to shock. Since training on Habit A or Habit B may obscure the effects of this bias, we will analyze only those animals that seemed indifferent to this training, viz., the D group. Are these animals actually assuming a new response with shock, or are they going back to some genetically prior response? We find from the data that only 2 of these animals selected a response on the critical trials that corresponded to their natural preference as determined by their 50 free choices. There are 2 additional ambiguous cases. These 2 animals on their 50 free choices preferred 2 alleys an equal number of times, thus exhibiting in a sense 2 natural preferences. On the shock trials these animals went to one of the two alleys they had preferred most on their free choices. Even by including these ambiguous cases, we cannot say that the D response was made to an original preference on the critical trials more often than we would expect by chance, for of these 15 animals by a conservative estimate only 2 made such a response and by the most liberal allowance only four exhibited this type of selection. Therefore, both the first experiment and the present one have failed to give us any evidence in support of the hypothesis that the animals go back to natural preference in the shock situation.

In preceding paragraphs we have been able to point to certain determining factors in the shock situation with considerable confidence. That other factors are operating in the situation may not, of course, be denied. We shall attempt, therefore, to analyze some of these possibilities. Table 5 indicates that the animals responded with a right turn, on the critical trials, with greater frequency than they responded with a left turn. Since almost exactly the same number of animals select each of the two middle alleys (*II* and *III*), we see that this discrepancy exists only with the end alleys

(*I* and *IV*). Certainly natural preference may not be considered as a factor contributing to the greater preference of alley *I*, for on the preference trials the animals selected the various alleys with the following frequencies: alley *I* was preferred by 13 of the rats on a majority of their preference runs; alley *II* was preferred by 2 of the rats; alley *III* by 13.5; and 31.5 of the rats preferred alley *IV*.[5] Thus we see that alley *IV* was unquestionably the most preferred alley on the preference runs while it was the least preferred on the shock trials. There are possibly two other factors in the physical situation that may have in some obscure way influenced the relative frequencies with which alleys *I* and *IV* were selected. One of these factors may have been the shape of the alley entrance, the other the unequal distribution of light to the alleys.[6] However, on the basis of our evidence it is utterly impossible to substantiate a claim that either of these two factors are of any unique significance in the shock situation.

It will be noted from the results of the sub-groups (Table 5) that the pattern of response varies with the combination of alleys used. If the training is confined to the end alleys (sub-groups B_1 and B_2), the bulk of the responses to shock are toward those alleys, and, likewise, if the training is directed toward the middle alleys (sub-groups C_1 and C_2), most of the shock responses are toward these alleys. Again where training is to both a middle and end alley, the preponderance of the shock responses are to middle alleys (sub-groups A_1, A_2, D_1, D_2, E_1, E_2, F_1, F_2). On these last groups interesting observations can be made on the way the two determining factors, availability of the alley and training, influence one another. For it is to be noted that training on either Habit A or Habit B to a middle alley is sufficient to bias the animal toward the selection of one of these alleys whether or not the critical response is made to the specific alley to which the animal was trained. Thus 90% (36 out of 40) of the animals that received training on middle alleys, selected a middle alley on the critical trials. Since these animals were given an equal amount of training on an end alley as on a middle alley, we should expect them to select end alleys with the same frequency that they select mid-

TABLE 7

Comparison between P, R, and D groups as to strength of Habit A in terms of number of correct choices out of the 50 training trials to that habit.

Group	N	Mean	Groups to be Compared	Diff.M	*t*	Reliability of Null Hypothesis
P	27	38.89	PR	1.28	.992	40%
R	18	37.61	PD	1.22	.083	100%
D	15	37.67	RD	.06	.038	100%

[5] Since 5 of the animals evidenced an ambiguous preference by selecting two alleys with equal frequency, it was decided to credit each of the two preferred alleys with one-half a preference. This accounts for the fractions in the above tally.

[6] In the construction of the apparatus it was intended that each alley should be as unique as possible in order to facilitate learning of the position habits. It was for this reason that the shapes of the alley entrances were made different from one another, and unequal distribution of light was left uncontrolled.

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dle alleys if training were the only factor. If the hypothesis that training augments the influence of accessible alleys is true, then animals not trained to either of the middle alleys should select these alleys with considerably less frequency on the critical trials. The animals, in sub-groups B_1 and B_2, substantiate this hypothesis in that only 30% of these animals select alleys *II* and *III* with shock. The availability of the alley accounts for the choices this 30% made.

Table 6 repeats the results shown in Table 5 in a somewhat different way. It shows the absolute number of trials on which the alleys were selected by all animals. It also gives the absolute number of P, R, and D runs for all animals according to the various sub-groups. This table when compared with Table 5 gives some idea of the fidelity with which the animals continued to go to the alleys selected on the critical trials. By comparing the percentages of the different types of responses as measured by the two methods we find almost complete identity, e.g., 18.33% of the animals chose alley *I* more than any other and 17.77% of all critical runs were to alley *I*. Again, 38.33% of the animals selected alley *II* with shock, while 36.97% of all the shock runs were to that alley.

Comparison of P, R, and D Groups

For convenience we have classified our animals as P, R, and D according to the alley they selected on the critical trials. It now becomes necessary to examine these groups from all possible vantage points in order to determine whether or not these distinctions are to be considered fundamental ones.

Other writers (3, 14) have contended that the relative strength of habits formed during the training period is an important factor influencing the animal's selection in the shock situation. In other words, the more frequently a habit is performed the more likely an animal is to select it on the critical trials. If this is true, we should expect that the animals in the R group would have made a significantly greater number of correct choices on their 50 training trials on Habit A than either the P or the D groups. This contention, however, finds no support whatsoever in the data presented in Table 7. There we see that the mean (column 3) of the correct choices on Habit A for the R group is 37.61 while for the P and D groups the means are 38.89 and 37.67, respectively. In column 5 we see listed the differences between the three groups. It is to be noted that the largest difference is between the P and R groups (row 1) and the smallest difference is between the R and D groups (row 3). In column 6 Fischer's t is presented for these differences, and the significance or "level of confidence" of t is presented in the last column. The figures in the latter column

TABLE 8

Comparison between P, R, and D groups as to strength of Habit B in terms of the number of correct choices out of the 50 training trials to that habit.

Group	N	Mean	Groups to be Compared	Diff.M	t	Reliability of Null Hypothesis
P	27	39.85	PR	.20	.208	90%
R	18	40.05	PD	.41	.383	80%
D	15	40.26	RD	.21	.228	90%

may be read as follows: if we repeatedly took pairs of samples of P and R (row 1) we should expect to find a value of *t* as large as .992 between 30% and 40% of the times. Thus we must accept the hypothesis that these two "samples were drawn at random from the *same* or identical populations" (10, pp. 57-58). In Tables 7 through 15 this hypothesis shall represent the null hypothesis (column 7). Since we are able to demonstrate that no reliable difference exists between the frequencies with which the P, R, and D groups select the positive alleys on Habit A, we are unable to point to frequency as a determiner of the R response.

Table 8 shows in the same way that no difference exists between the frequencies with which the P, R, and D groups made correct responses on Habit B. Therefore, we must again reject the hypothesis that strength of habit as indicated by the frequency of response determines the selection of the response in the critical trials.

Hamilton and Krechevsky (7) have pointed to the importance of variability in these shock experiments and have described a measure for it that can be applied in the two-choice situation (p. 243). However, we were unable to use this measure for the quadruple-choice apparatus. On the other hand, Elliott (2) has devised two measures of variability specifically for the multiple-choice situation, but unfortunately we felt that neither of these measures was direct enough to fill our needs adequately.[7] Our variability score was obtained by counting the number of shifts in response the animal made on any one day. If an animal did not make any two successive choices to the same alley on his 10 daily runs he would receive the greatest variability score, 9, that could be obtained on 10 trials. If his first choice was repeated on all trials his variability score would be zero. This score differs from both Hamilton and Krechevsky's and Elliott's scores in that it measures changes or shifts in behavior rather than kinds of behavior.

TABLE 9

Comparison between P, R, and D groups as to average variability exhibited in learning Habits A and B.

Group	N	Mean	Groups to be Compared	Diff. M	*t*	Reliability of Null Hypothesis
P	27	15.27	PR	.50	.347	80%
R	18	15.77	PD	1.03	.682	50%
D	15	16.30	RD	.53	.288	80%

In Table 9 we see a comparison between the P, R, and D groups on variability exhibited in the learning of Habits A and B. The average variability of each animal on these two habits was obtained by totaling the daily variability scores made by each rat on the 10 training days and dividing by 2 (the number of habits). Again we see the marked uniformity between the three groups emphasized. Thus we are able to say that before the critical trials the P, R, and D groups were alike in strength of position habits as measured by frequency of response to

[7] The measure preferred by Elliott was based upon the sigma of the distribution of choices to the 4 alleys. This we feel emphasizes the number of different kinds of responses made rather than the variability in behavior. In this sense Elliott's score may be used as a measure of "behavior repertoire" (11, p. 249) more accurately than as a measure of variability.

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the positive alleys and in the degree of variability shown.

Table 10 shows the marked decrease in variability on the critical trials. In column 3 we see that the animals in the P group made only an average of 2.22 shifts in responses during the entire 50 shock trials. The great lack of variability shown in this group may be illustrated by pointing out that if every animal in this group made only one deviation from the perseveration alley (provided this deviation were not made on the first or last trials of any day) the average score for the group would be 2. We note, however, that the R and D groups exhibit significantly greater amounts of variability than the P group. for the differences in variability between the P as compared with the R and D groups. That the shift and not an actual increase in variability is responsible for this difference is further substantiated by the fact that the two groups that did shift on the critical trials (R and D) showed insignificant differences in variability.

TABLE 10

Comparison between P, R, and D groups as to the amount of variability exhibited on the 50 critical trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	2.22	PR	3.88	2.732	1%
R	18	6.1	PD	2.18	2.202	5%
D	15	4.4	RD	1.70	.961	40%

In our first experiment we had noted a tendency for animals to refuse to eat during the shock trials. Therefore, in the present study we decided to observe their behavior in the food box more closely. The criterion used to measure food refusals was a rough one. If the animal did not eat immediately after being released from the detention chamber, he was allowed at least 30 seconds in which to approach the food. If his actions at the end of this period seemed indicative of acceptance of food, he was given a longer time in the food box. If on the other hand he exhibited complete indifference to the food, he was immediately started

TABLE 11

Comparison between P, R, and D groups as to the number of food refusals on the 50 critical trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	20.93	PR	2.68	.680	50%
R	18	23.61	PD	2.73	.702	50%
D	15	23.66	RD	.05	.010	100%

It will be recalled from our first experiment (Table 1) that after the first shock trial there was a shift away from the perseveration alley toward the regression and digression alleys. Such shifts, of course, increase the variability scores. Thus this disruption of Habit B accounts

on the next trial. The errors produced by this method would thus tend to reduce the recorded number of food refusals. In spite of this procedure Table 11 indicates that the animals refused food on somewhat more than 40% of their critical runs. Again we find that no differences exist between the P, R, and D animals.

the disruption of the habit in progress did not always occur immediately at the start of the critical shock trials, which accounts in some measure for the lower frequencies of response to the regression and digression alleys on the critical shock trials.

Tables 13, 14, and 15 contain interesting information about the strength of

TABLE 12

Comparison between P, R, and D groups as to the frequency with which the animals selected the alley most preferred on the 50 critical trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	48	PR	6.28	3.27	1%
R	18	41.72	PD	6.34	3.94	1%
D	15	41.66	RD	.06	.02	100%

Table 12 shows a comparison between the P, R, and D animals as to the frequency with which they selected the alley they most preferred on the 50 critical trials. The results presented in this table parallel those presented in Table 10 and for the same reasons. The P animals showed that on the average they make but 2 deviations away from the perseveration alley, i.e., they went to the perseveration alley 48 times out of 50, while the R and D animals did not go so consistently to the regression and digression alleys. No difference, however, exists between the R and D animals on this measure. In these two groups of animals

the fixations formed by the shock. We have already seen (Table 8) that under normal conditions of learning the animals readily shifted from Habit A to Habit B making a relatively few number of errors. Table 13 reveals how difficult it was for the animals to be retrained in an *old* habit after the 50 shock trials. It will be remembered that for the P group the positive alley during the 50 retraining trials was the alley to which the animals had been trained on Habit A, and for the R and D groups the positive alley on these trials was the alley to which the animals had been trained on Habit B. While the P, R, and D

TABLE 13

Comparison between P, R, and D groups as to the number of errors made on the 50 retraining trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	34.00	PR	.28	.069	100%
R	18	34.28	PD	9.07	1.955	10%
D	15	24.93	RD	9.35	1.823	10%

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groups all show evidence of fixation, the D group made fewer retraining errors than either the P or the R groups. Although this difference may be accepted at only the 10% level of confidence, it may be indicative of the effects of past experience upon the strength of fixation. Thus it may be that training on either Habit A or B augments the fixation produced by the shock. Since no difference exists between the number of retraining errors made by the P and R groups, the recency of the training does not appear influential.

In Table 13 all of the errors the animals made during the retraining period are indicated, but in Table 14 we have recorded only those errors that the animals made by continuing to go to the alley they had fixated during the shock on a specific alley, i.e., the retraining period was characterized by stereotyped behavior rather than an increase in random errors.

Table 15 shows that with the cessation of shock there was an increase in the amount of variability (see Table 10). It also shows that the R group exhibited slightly less variability than either the P or the D groups. Either this difference is insignificant or it indicates that the positive alley exerted a greater influence on the R group during the retraining period than it did upon either the P or D groups.

TABLE 14

Comparison of P, R, and D groups as to the number of fixated responses on the 50 retraining trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	29.00	PR	1.94	.426	70%
R	18	30.94	PD	9.13	1.863	10%
D	15	19.87	RD	11.07	1.952	10%

Comparison between Experimental and Control Groups

Table 16 presents a comparison between the experimental and control groups on a number of different measures. In the first two columns we see comparisons of the strength of Habits A and B as measured by the number of correct responses made to the positive

TABLE 15

Comparison between P, R, and D groups as to the amount of variability exhibited on the 50 retraining trials.

Group	N	Mean	Groups to be Compared	Diff.$_M$	t	Reliability of Null Hypothesis
P	27	10.55	PR	4.00	1.717	10%
R	18	6.55	PD	.58	.206	90%
D	15	11.13	RD	4.58	1.715	10%

trials. The close correspondence between the figures in this table and those of Table 13 indicates that the great majority of the errors made on the retraining trials was due to the fixation

alleys. On Habit A the experimental group made an average of 38.20 correct responses while the control group made an average of 37.80. The obtained *t* (.127) indicates that the difference of .40 is negligible. On Habit B the experimental group made slightly more correct responses than the control group. While the difference may not be regarded as highly significant, the fact that the control group was trained to its least preferred alley on Habit B probably accounts for the obtained difference. In column 3 it may be seen that no difference exists between the experimental and control groups in the average variability scores for Habits A and B.

In the fourth column we see, as would be expected from the results of other writers and those we presented in the first experiment, that the experimental shock group exhibits less variability than the control group, i.e., the experimental group obtained a score of 3.93 while the control group obtained a score of 8.80. However, the size of the obtained *t* (1.441) indicates that this difference may be accepted only at the 20% level of confidence. In presenting the results of Table 10 it was indicated that the R and D groups showed a somewhat greater amount of variability in the shock situation than the P group, and it was pointed out that this difference may be due to the delayed disruption of Habit B by some of the R and D animals. This being the case, by comparing the control group with the combined P, R, and D groups, we are distorting the picture of the effect of shock upon variability. The effect of the shock trials may be more accurately represented by comparing the P group with the control group, because the shock failed to disrupt the responses of the P animals on the critical trials and thus both this group and the control group are equivalent in that both continued to react in the direction of the second habit.

TABLE 16

The comparison between the experimental and control groups on strength of Habits A and B, variability for Habits A and B, variability for retraining, retraining errors and fixated choices. Comparisons are also shown between the critical trials for the experimental group and Habit B′ for the control group on variability and frequency with which the animals went to the alleys selected on a majority of these trials.

	Strength of Habit A	Strength of Habit B	Average Variability for Habits A & B	Variability on critical trials*	"Stereotypy" on critical trials*	Retraining errors	Fixated choices on retraining	Variability for retraining
Experimental Group	38.20	40.02	15.68	3.93	44.53	31.83	27.30	9.50
Control Group	37.80	37.80	17.35	8.80	44.50	7.70	4.80	10.60
Difference	.40	2.22	1.67	4.87	.03	24.13	22.50	1.10
t	.127	1.982	.313	1.441	.012	10.629	13.554	.347
Reliability of Null Hypothesis	100%	10%	80%	20%	100%	1%	1%	80%

* The trials compared here are the shock trials for the experimental group and the second 50 training trials on Habit B (Habit B′) for the controls.

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We see from Table 10 that the mean of the P group is 2.22 and from Table 16 that the mean variability score of the control group on their second 50 training trials in Habit B (Habit B′) is 8.80. For the difference between these two groups (6.58) we obtained a t of 4.476. A t as large as this could be found by chance less than 1% of the time. If the hypothesis that the increased variability of the R and D groups over that of the P group is due to the fact that the disrupting effect of the shock is delayed to the extent that it causes many of the animals that make P responses on the first few trials to shift to R and D responses, then we should expect most of the variability of the experimental group to occur on the first few trials. Figure 2 indicates that this is the case. From this figure we see that a sharp decline in the variability of the experimental group occurs after the first day while the control group shows no such tendency.

Under the heading of "stereotypy" in column 5 (Table 16) is given the number of times the animals in the experimental group went to the alleys selected on the majority of their shock trials (44.53) and for the control group the number of correct choices made on Habit B′ (44.50). Oddly enough we find the groups to be practically identical on these two measures. Thus we would be forced to say on the basis of the frequency with which these two groups responded to the various alleys selected under these two conditions that they had formed habits of equal

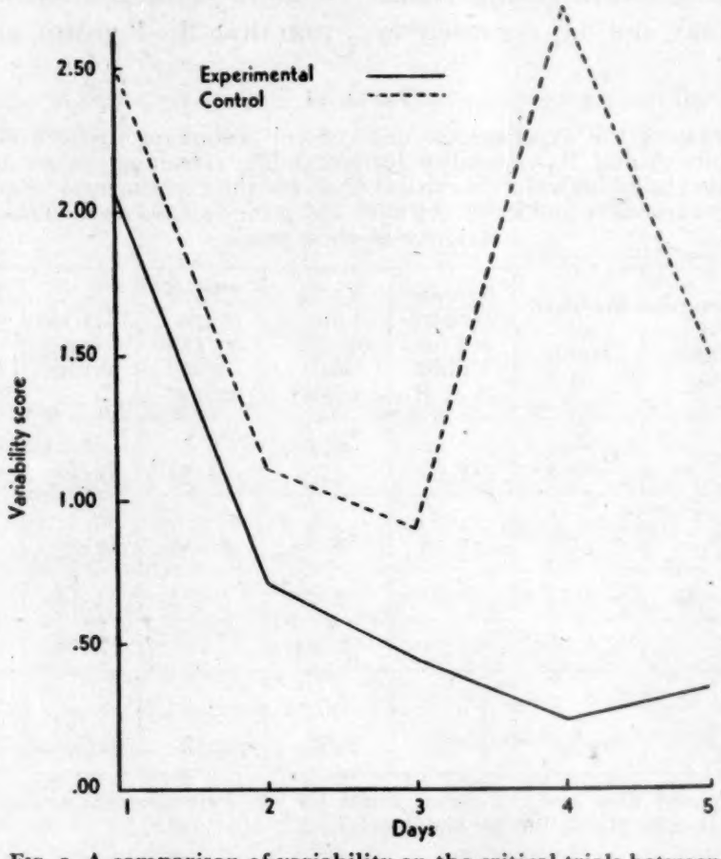

FIG. 2. A comparison of variability on the critical trials between the experimental and the control groups. On these 50 trials the experimental group received shock whereas the control group did not.

strength. Likewise, we would be unable to state from these figures that the experimental group showed any more fixation than the control group, and thus might then conclude that "overlearning" on Habit B produced fixations of the same order as shock. But the inadequacies of measuring the strength of fixation by the response to the shock situation during the critical shock trials. The distribution of the retraining errors is shown in Figure 3. Here we see that the animals in the control group making the largest number of errors fell in the range between 10 and 15 (actually the largest number of errors made by any animal in the control group was 12), while in the experimental group we see

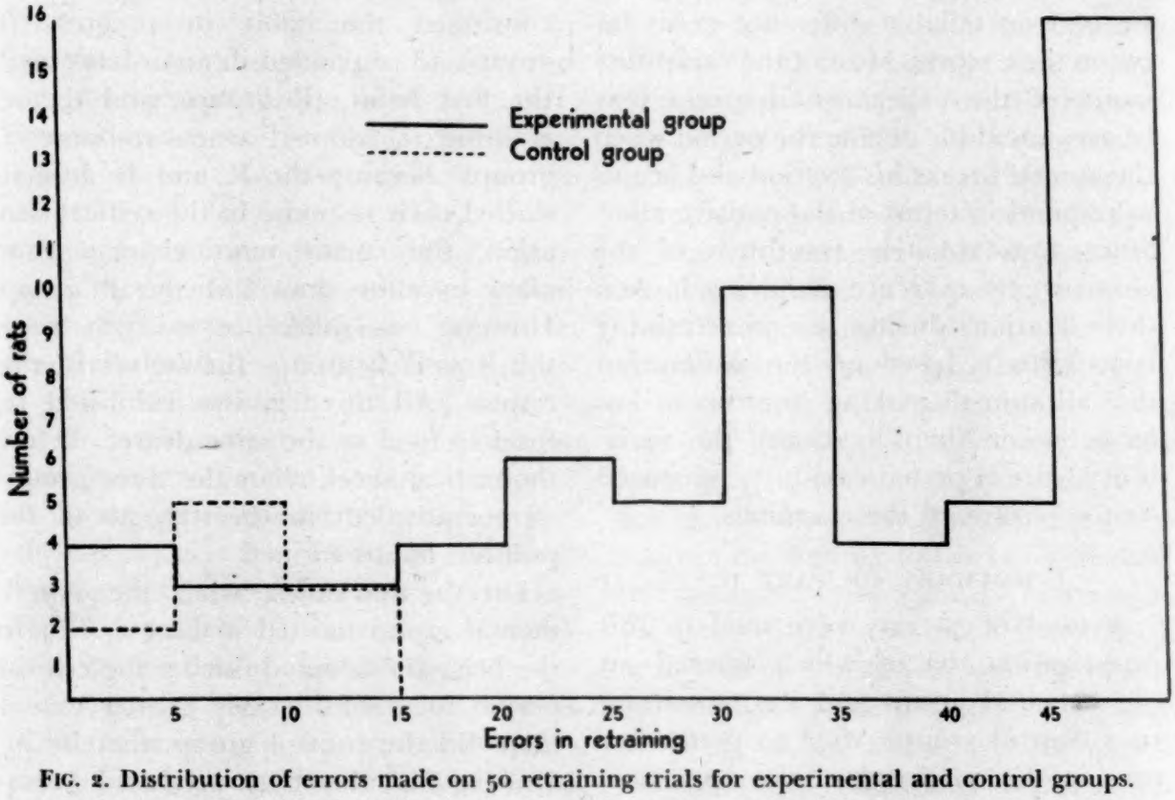

FIG. 2. Distribution of errors made on 50 retraining trials for experimental and control groups.

have already been pointed out (Part I). The data presented in the sixth column amply support this contention. Here we see how very strong the fixation produced by shock was, for on their 50 retraining trials the experimental animals made an average of 31.83 errors while the control group made but 7.70 errors. The high reliability of this difference is indicated by a t of 10.629. It must not be thought that these errors were spread in a random fashion, for in column 7 it may be seen that 27.30 of these errors were made by continued selection of the alley fixated that the modal number of errors fell between 45 and 50. Of the 16 animals falling in this group, 10 made errors on all 50 responses. Nine animals made all 50 responses to the alley fixated during the shock trials, and an additional 3 animals made 49 such responses. Thus for these animals in the upper end of the distribution we have no complete measure of the strength of their fixation. By taking this into account and by noting also that the average fixation score includes some animals from the lower end of the distribution, i.e., at least those

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overlapping the control group who gave no evidence of fixation, it will be seen that the figure representing the difference between the experimental and the control group is a most conservative estimate of the strength of the fixation produced by shock.

In the last column the variability scores for the experimental and control groups are given. It is not surprising that we find no reliable difference exists between these scores. Most of the variability scores of the experimental group may be accounted for during the period when the animal breaks his fixation and begins to respond in terms of the positive alley. Since approximately two-thirds of the animals gave evidence of having broken their fixations during the 50 retraining trials (this is based on the assumption that all animals making 40 errors or less have broken their fixations), the variability score is perhaps unduly influenced by the records of these animals.

SUMMARY OF PART II

A total of 70 rats were used in this investigation, 60 of which formed an experimental group and the remaining 10 a control group. After 80 preference runs in the quadruple-choice apparatus (30 forced choices and 50 free choices), each animal was given 50 trials to form Habit A to one of the four alleys. After this training the positive alley was shifted to another alley, and 50 training trials were given to form Habit B. To control alley availability each sub-group was trained on a different combination of two alleys. Electric shock was then administered to the animals at the choice point for the next 50 trials. On the following 50 trials no shock was given, and there was an attempt made to retrain the animals in a response other than the one adopted on the shock trials.

The control group of 10 animals was subjected to the same training procedures as the experimental group, but instead of shocking these animals at the choice point after the 50 training trials on the second habit, they were given an additional 50 trials under unaltered conditions.

The results show that during the shock trials 27 of the experimental animals continued the habit in progress (P group), 18 responded in accordance with the first habit (R group), and the remaining 15 adopted a new response (D group). Because the R and D animals shifted their response in the critical situation, they made more changes from alley to alley than did the P group. However, no difference exists between the R and D groups themselves in this respect. All three groups exhibited refusal to food to the same degree. Before the critical shock trials the three groups were equivalent in the strength of the position habits formed.

On the retraining trials the experimental group resisted making a shift in the behavior adopted during the critical period to a considerably greater extent than did the control group, thereby indicating that the shock produced a fixation of behavior. No greatly significant differences were found in the strength of fixation between the P, R, and D groups. That the P and R groups showed slightly higher strengths of fixation may mean that learning on the first and second habits combined with the electric shock to produce the stronger fixation.

DISCUSSION AND CONCLUSIONS

The original purpose of this study was to discover whether or not the regression described by other animal experimenters was an artifact of the experimental situation and procedures, or whether in

reality an analogue of the human psychopathological mechanism of regression had been described. If the latter conception of this phenomenon is to be substantiated then indeed we should expect to find certain differences between the animals exhibiting this type of behavior and animals not so doing. That is, of course, differences other than the particular alley selected on the shock trials. To demand such proofs is not to question the validity of the assumption that the general design of these experiments is adequate for the demands imposed upon it by the problem to be investigated. In other words, in order to make a comparative study of regression, the proposition has been accepted that by establishing two successive, mutually exclusive, habitual ways of reacting in a particular situation, we have created an analogue to the successive establishment in the human being of more and more mature responses to particular situations. That this has been done may be questioned but rejection of the hypothesis must remain unsubstantiated by experimental evidence.

It has been found in both experiments that the animal in the critical situation need not necessarily confine himself to responses in which previous training was received, i.e., he may develop a new response (D). The question may well be asked whether both the R and D responses may not be equally new in this situation. However, the greater frequency with which the R response occurs indicates that previous training may facilitate the selection of an alley in the shock situation. It may also be remembered that the R group seemed slightly more fixated than the D animals (Tables 13 and 14). This seems to support somewhat the identification of the R response to historical regression. However, let us make a more detailed analysis of the entire experimental group in order to ascertain whether or not this identification is valid.

In previous studies the regressive behavior was considered to be an inadequate response to the situation, i.e., at least by an objective standard. In these studies the animal that "regressed" was taking the long way to the goal or he was frustrated momentarily before reaching the food box. This point of view encouraged the analogy between this phenomenon and the Freudian idea of regression. If this analogy is going to continue to be recognized, then at least it is necessary to ascertain whether this objective inadequacy of the R response really obtains. Furthermore, to say that the R response is inadequate implies that the P response must be an adequate one, and that the P group is responding on the basis of that adequacy. Our second experiment demonstrated that the P group was not responding to the habit in progress because it was adaptive in terms of the goal (food), any more than the R or D groups, for we see in Table 16 that on somewhat more than 40% of the critical trials all the animals in the experimental group refused to eat. Furthermore, Table 11 shows us that the animals making the P, R, and D responses were alike in the number of food refusals in the shock situation. In addition to this, unlike O'Kelly (16), no distinction has been found between the P, R, and D responses in such a way that would make the R response understandable only by resorting to some fundamentally different mechanism. During the shock trials these animals were remarkably similar to those in the other two groups in all observable behavior characteristics. The slight difference in variability between the P group and groups that discontinued

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Habit B was accounted for by the disruption of that habit, and, as we have just pointed out, there was no difference in amount of food refusals. Nor could distinctions of any significance be found on retraining, although it did seem here that training on either Habit B or A augmented the strength of the fixation formed. Yet even this implies that R is not unique for strength of R fixations and P fixations were almost identical. This evidence it seems destroys the thesis that the R response, as a uniquely inadequate way of responding to the shock situation, should be considered as historical regression. It points rather to fixation as the fundamental and prevailing type of behavior exhibited in this situation.

In the shock situation one of the very important determiners of behavior appears to be the availability of the alley. In our analysis of the results presented in Table 5 we pointed out that 78.33% of all the animals chose either alleys *II* or *III* on the critical trials. Since these two middle alleys are the most accessible ones for the rat in this situation, and since on the basis of training alone we would have expected but 50% of the animals to have selected these two alleys, we may say confidently that this factor of alley availability exerts a very important influence on the animal's behavior in the shock situation.

Since 18 of the 33 rats that did not fixate the habit in progress on the critical trials went to an alley on which they had previously received training, we must conclude that training on the first habit is effective to some degree in determining the type of response made in the shock situation.

By analyzing the data obtained from animals that did not exhibit the influence of their previous training in the critical situation, it was hoped that the effect of natural preference might be uncovered. However, no results were obtained to substantiate the influence of natural preference or genetic bias as a determiner of the response in the shock situation, for of the 15 animals in the D group only 2 selected an alley on their shock trials that coincided unambiguously with their natural preferences. Thus we must conclude that either natural preference is not a determiner of response to the shock situation or that it is so impotent a factor that it is readily masked by other determining factors.

We have likewise been unable to verify the hypothesis that the relative strengths of the two habits formed during the training period determine the response selected in the shock situation. Thus we did not find that the R group had formed a relatively stronger first habit as measured by the frequency of correct responses on Habit A, nor that the P group had a relatively stronger second habit. Rather we found exceedingly small differences between the P, R, and D groups on the frequency of correct responses on Habits A and B.

The work on the second experiment substantiated the results on the first, for when the experimental group was compared with the control group (Table 16) the fixating effect of the shock was revealed in all its strength. Figure 3 also shows dramatically how much more difficult it was to break up the response formed to shock than it was to change the response that was merely augmented by additional training. The fact that the D group made an average of 24.93 errors on the retraining trials, while the control group made but 7.70, shows that shock for 50 trials makes a response much more difficult to alter than mere training for 100 trials.

While our second experiment definitely established the fixation of the experimental group by comparing it with an unshocked control group, the first experiment gave a more striking demonstration of its strength. In the latter study even punishing the animal in the fixated alley proved ineffective in causing him to alter his behavior. Thus while it appears reasonable, in line with the earlier discussion, to postulate that the animal's behavior is no longer food directed in the shock situation but rather is motivated by the need of escape from shock, apparently the strong motivation enduring for an extended period of time introduces some factor that so fixates the response of the animal that even when the conditions are altered in such a way that this response leads to shock rather than away from it the animal fails to abandon it.

It is felt that one of the more interesting results obtained in this investigation occurred when the attempt was made to retrain the fixating animals on the first experiment by means of forced runs. The fact that the animals had failed to quit their fixation even when punished for it indicated that the animals were fixated on a particular alley rather than merely avoiding some particular response. Two possible explanations of this specific fixation presented themselves. One was that the rats were selecting this alley merely because its excitatory value was so high that responses to the other alleys were precluded. The other was that subjectively the animals had but one behavior possibility, the fixated alley. With these explanations in mind we attempted to retrain the animals by forcing them to enter all alleys by successively blocking the alley to which they had just run. (It will be remembered that only trials 2, 3, and 4 were forced runs.) Somewhere in the course of this training 10 of the 16 animals refused to run. Thus when the fixation was disrupted, 63% of the rats failed to replace this response with another response of the same order, i.e., selection of another alley.

If the fixation were occasioned by a high excitatory value for the fixated alley and low excitatory values for all other alleys, we would have reason to suspect that with the disruption of the fixation, a response to another alley would take its place readily. If it should be argued this would not necessarily follow, because high inhibitory values had been set up to the remaining alleys, an explanation showing how these inhibitory values could be established would be required. This would be difficult because these animals had relatively few frustrations in alleys other than the fixated one, i.e., alleys *I, II,* and *III.* If the fixation resulted from the piling up of excitatory increments it would mean merely that we were dealing with an extraordinarily well learned habit. The implication would also be that the organism is responding in a way relative to the excitatory values of the other alleys. Then with the reduction of the excitatory value of the fixated alley brought about by the frustration imposed by the temporary blocking of that alley, we should expect the excitatory values of the new positive alley to build up gradually until this alley should supersede the fixated alley as the preferred one. In this case we would be dealing with a continuous learning function, and the mechanism of fixation would be no different from the mechanism of learning.

If, however, this fixation is to be considered as abnormal and different from learning (11), the positional response of the organism need not be relative to other mutually exclusive responses, i.e.,

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responses to the other alleys. The fact that a great many animals refused to respond in the situation when their fixated response was blocked cannot be adequately explained by postulating that shock choices are determined by excitatory values. If this were the determining factor then elimination of the highest excitatory value should merely cause a shift in behavior toward the alley with the next highest value. While it is not felt that the evidence is conclusive, it is deemed plausible that the shock caused such a channeling of behavior that subjectively the animal was in a one-alley situation.

To support the contention that the fixating rat in reality has but one response to the situation further experimentation involving a variety of techniques of blocking the responses and a variety of situations is called for. Abnormal fixation studies call for increased motivation in order to get the animal to respond in the situation. When this is done the dominant need becomes escape from the situation. With the application of this technique on the jumping apparatus, it becomes impossible actually to block the fixated response. Blocking the fixated window fails to prevent the response, because the jump from the platform whether to an open or closed window allows the animal to escape from the situation, i.e., by either going through the window to food or by bumping his nose and falling to the floor. However, the response is certainly blocked in the discrimination box when the animal is prevented from entering the fixated alley, because even though the animal leaves the starting place he must select another response or remain in the situation. Thus the most conclusive proof of the contention that the fixating animal has but one response to a situation will come from situations like those defined by the discrimination box.

As a consequence of a detailed study of the results of the two experiments described herein, the writer feels compelled to conclude that the fundamental problem in the so-called studies of regression in animals is fixation. No convincing evidence has been found that the R response is so essentially different from the P and D responses that it alone should be selected from these three and be dignified as an analogy to the psychopathological phenomenon of regression. This, of course, is very clear cut when we mean by regression an actual reversion to a mode of response or habit typical of an earlier developmental stage in the life of the individual, i.e., historical regression. However, if we are to adopt the ahistorical interpretation of Lewin, reasons for concluding that we have not found regression are not immediately apparent. For him regression means the assumption "under pressure" of a more "primitive" level of behavior. How "primitive" the level of behavior is, is defined by the degree of differentiation possessed by the organism in the "high pressure" situation (9). A fixating animal certainly seems to be exhibiting a low degree of differentiation. Does it necessarily follow from this that the fixated response must be considered as a "regression," and as such analogous to regression in the human being? That may be so, but it is felt that we would have little to gain by making such an analogy, while it is very possible that by so doing much would be obscured or distorted by forcing its acceptance.

Fixation has been recognized in rats as a distinct phenomenon by a number of different experimenters. Many of the studies have dealt primarily with the description of a particular factor that serves

as a fixating agent. Some of the earlier studies have emphasized the role of overlearning as producing fixation in behavior (4, 8). Maier (11), however, believes that a distinction should be made between habit fixation, as this term is traditionally used, and abnormal fixation. The abnormal fixation, he believes, results from a mechanism different from the ordinary learning mechanism. The results of this study seem to point to fixation as an abnormal mechanism outside the bounds of ordinary learning. In the light of this hypothesis the functioning of overlearning must be very carefully examined to see whether or not continued repetition is capable of producing fixations of such character that they may be classified as abnormal.

Brain lesions have been shown to produce a type of organism that is prone to fixation. Hamilton and Ellis (5, 6) for example have shown that brain injured animals readily adopt fixations, but show little persistence in seeking a goal that is not readily obtained. They point out that persistent behavior is goal directed, while fixated behavior is merely repetitious in that the goal seems to recede as a determining factor. This study also presents evidence for the lack of potency of the goal in the fixated response. These results indicate that the goal shifts from food to escape from shock, but that when the response becomes fixated it is still continued even though it leads to shock instead of away from it.

Maier, Glaser, and Klee (13) have pointed to the importance of frustration as a fixating agent. They have shown that rats when placed in the frustrating, no-solution situation on the Lashley-type discrimination apparatus develop position habits that resist even 100% punishment. It has been felt that in this experiment the fixating agent somehow results from the strong motivation produced by the shock. The present situation had no comparable elements of frustration such as those present in Maier, Glaser, and Klee's experiment (unsolvable problems), but it is felt that their situation had in common with this one an increased motivational factor, viz., the air blast. Thus it seems possible that the unbreakable fixations they produced were influenced by the accumulative effects of frustration and compelling motivation.

In order to determine the actual fixating element it will, of course, be necessary to abstract from all fixating agents the essential common factor. It will also be necessary to prove that the various fixating agents actually produce fixations of the same order. On the assumption that both Maier, Glaser, and Klee and the present study have produced similar abnormal fixations, one may speculate on the common factor involved in the two situations. It is believed that in both the frustrating situation and in our shock situation there comes into being an emotional element that is specifically associated with the particular situation. It is this emotional element as a product of the strong motivation or the frustrating situation that may account for the development of the abnormal fixation. For the present, however, this contention must remain without complete experimental verification.

GENERAL SUMMARY

In a quadruple-choice apparatus in which rats were given two successive position habits, three responses to electric shock were obtained: (a) selection of an alley to which the rat had formed his first position habit, (b) continuation in the second position habit, (c) selection of an alley on which the animal had

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never received training. It was found that accessibility of the alley and training on the first and second habits were effective determiners of behavior in the shock situation, whereas strength of the position habits and natural preference were not. Since no real distinctions other than the type of alley selected were discovered between the animals exhibiting the three different responses to the critical situation, it seemed incorrect to assume that the animals selecting an alley to which they had first been trained were exhibiting so unique a mechanism that it should be considered as analogous to the human psychopathological phenomenon of regression.

The primary positive contribution of these experiments is to produce conclusive evidence that electric shock is a factor of great importance in producing abnormal behavior fixations in the rat.

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